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ABSTRACT

This paper discusses the problems associated with mathematics anxiety, and provides detailed information on the history and structure of the Mathematics Anxiety Program at the University of Minnesota. The seven parts concern: (1) the Continuing Education for Women Program, (2) the development of the Math Anxiety Program, (3) the symptoms of mathematics anxiety, (4) the success of the Math Anxiety Program, (5) the major components of the Math Anxiety Program, (6) the arithmetic and elementary algebra course offered through the program, and (7) the methods used to teach math anxious students. Appendices include the mathematics placement test, interpretation of mathematics test scores, math anxiety course descriptions, the modular art handout used in clinics, and the course outline for arithmetic and elementary algebra. (MNS)

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Math Anxiety - Causes and Solutions

presented at the

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INTRODUCTION

The Mathematics Anxiety Program offered through Continuing Education for Women at the University of Minnesota was initiated in 1976 to meet the needs of students who experience debilitating fears and frustrations when working with mathematics. Since that time, over 5,000 students have enrolled in one or more components of the program.

This paper provides detailed information on the problems associated with mathematics anxiety and on the history and structure of the Mathematics Anxiety Program at the University of Minnesota. The paper is broken up into seven parts which describe the following:

1. The Continuing Education for Women Program
2. The development of the Math Anxiety Program
3. The symptoms of math anxiety
4. The success of the Math Anxiety Program
5. The major components of the Math Anxiety Program
6. The arithmetic and elementary algebra course offered through the program
7. The methods used to teach math anxious students.

DESCRIPTION OF THE CONTINUING EDUCATION FOR WOMEN PROGRAM

Continuing Education for Women (CEW) is a program within the division of Extension Classes, which is one of sixteen departments within Continuing Education and Extension (CEE) at the University of Minnesota. CEE is the unit of the university whose mission is the extension of the many resources of the University to the community at large.

Approximately 350 University accredited courses and non-credit classes and workshops, serving over 6,000 students per year, are offered through CEW at times and locations convenient for the non-traditional students of the program. Established in 1960 as the Minnesota Plan for Continuing Education for Women, CEW has expanded to include many course offerings in diverse areas of knowledge and skill. The idea of CEW, relating higher education to the changing needs of women, was rooted in the belief that women constituted one of the significant untapped resources of the nation. Its objective was to identify the educational needs of women past the traditional age of college students and to provide the educational resources that would assist them in developing their abilities to the fullest.

Today women enroll in continuing education classes for many different reasons:

1. To acquire the skills for jobs needed to financially support themselves and their families

2. To earn college degrees in order to advance in their present positions or to change careers

3. To finish interrupted educations because of lessened family responsibilities

4. To fulfill the need for personal growth and enrichment.

Unlike the early years of the program when most students were homemakers, the students now include many more women employed full-time or part-time outside the home.

Approximately 94% of the students enrolling in all CEW courses are female. The Mathematics Anxiety Program, however, enrolls approximately 15% males. Students in the program range in age from 13 to 93, with about half under the age of 36. The largest percentage (25%) are between the ages of 18 and 29, and 8% are 62 or older. For more details on the CEW program, see Hendel and Mucke, 1980.

DEVELOPMENT OF THE MATHEMATICS ANXIETY PROGRAM

In 1975, a professor of economics and the the chairperson of the Accounting Department, both of whom taught credit classes for Continuing Education for Women, came to CEW to discuss the problems women in their classes were experiencing. These women were highly intelligent and motivated, many had earned college degrees or had successfully completed some college work, but were having difficulty coping with the quantitative aspects of the accounting and economics courses.

The CEW staff began to investigate the situation by talking to the students, conducting research in the area of problems women have with mathematics, and further discussion with the instructors. The CEW staff discovered the term "math anxiety" had been coined and found that the symptoms of math anxiety accurately described the reaction toward mathematics experienced by some of the CEW students. The symptoms included blocking out numbers, avoiding situations requiring the use of mathematics, not remembering simple computations, and development of tension when faced with computations and testing.

Planning began for the purpose of developing an educational program to benefit the students having problems with mathematics. The planning process took ten months and required the cooperation of seven departments within the University including the School of Mathematics, Continuing Education and Extension Counseling, the Student Counseling Bureau, the Accounting Department, Measurement Services, Continuing Education for Women, and the General College.

The General College was particularly responsive because, being the open-admissions unit of the University of Minnesota, they deal primarily with students not adequately prepared for college level work. They helped CEW identify courses, credit and non-credit, that should be developed, methods of instruction and, most importantly, provided instructors especially gifted in teaching students having difficulty with mathematics.

In September, 1976, aided by a grant from the Center for Educational Development, a major math anxiety program was initiated. Offered through CEW, the program was designed for students who wished to overcome their feelings of anxiety toward mathematics and improve their math skills. The grant provided seed money for one year and, since that time, the program has been self supporting and has received national recognition. Beginning with 102 students in 1976, the program today serves over 1000 students per year. For more information on the development of the program, see Hendel, 1977.

THE SYMPTOMS OF MATH ANXIETY

Math Anxiety is a term which, having been coined in the mid seventies, is now recognized by many individuals. As people have become more aware of the idea of "math anxiety" they are also more willing to say they need help with math. The definitions and causes of math anxiety do not apply equally to all individuals; each person's experience is uniquely their own.

Math anxiety and mathaphobia are two terms used to describe the irrational fear of mathematics. The tension and anxiety this produces interferes with the use of numbers and solving mathmatical problems. The following characteristics are often associated with mathematics anxiety:

1. Intense emotional reactions to numbers: An individual's reaction to math can range from mild distaste to completely blocking out numbers and the avoidance of any situation where math is necessary.

2. Avoidance of mathematics: Because they have avoided mathematics over long periods of time, those who are afflicted with math anxiety typically exhibit below average ability. This lowered ability in turn compounds the anxiety associated with mathematics. A spiraling effect is created -- anxiety results in avoidance which results in reduced ability to perform mathematical operations which generates increased anxiety, and so on.

3. Poor preparation in mathematics: A prolonged absence from school or move to a new school can have a particularly adverse affect on a child's feelings about math. Mathematics is a subject which builds upon itself; missing a concept can be very confusing. Until the missing topic is learned there is a feeling of helplessness, that something basic should be understood, but is not. As this feeling compounds, anxiety develops, avoidance can occur, and eventually students will give up. Feelings and experiences of this nature can be carried into adulthood. Until the missing topic is learned, an individual finds it difficult to go on to the next section of math. Isolating what one does not know makes it possible to learn the material for the first time or to relearn it, and go on to subsequent subjects.

4. Test anxiety: Situations in which one is expected to prepare for and take exams often produce the higher levels of anxiety and these emotional responses interfere with concentration and performance. Testing can also reawaken memories in the adult of earlier classroom situations that were negative experiences and these are associated with math performance.

SUCCESS OF THE CEW MATH ANXIETY PROGRAM

A study was carried out in 1981 for the purpose of determining the level of success of the CEW Math Program in reducing the levels of mathematics anxiety of the participants (Lorenz and Hendel, 1981).

Generally, the program has been most helpful in assessing math abilities and in the improvement of math skills and attitudes toward math. Sixty-seven percent of the 151 students questioned said that their feelings about math had changed as a result participation in the program. Specific comments included the following: improvement in feelings about math; gaining confidence in math; enrolling in subsequent math classes or classes whose content is closely related to mathematics (e.g., business or chemistry); changes in educational goals in order to pursue a degree or continue with one already started; changes in occupational goals; consideration of working with math specialties within a field; taking jobs requiring math ability; adding math to job activities; promotion because of newly acquired math skills. Only one respondent indicated a more negative attitude toward math at the end of the program than at the beginning.

MAJOR COMPONENTS OF THE MATH ANXIETY PROGRAM

The the Mathematics Anxiety Program of Continuing Education for Women consists of four interrelated parts: the Diagnostic Clinic, the Support Groups, the Math Tutorial, and the Math Courses.

1. Diagnostic Clinic:

These three and one half hour clinics are offered ten times per year to the general public during the day and in the evening, as well as to specific groups who request them, such as Northwestern Bell, UNIVAC, and the State of Minnesota.

The clinics serve two purposes: First, they provide participants with information concerning their math skill levels and levels of math anxiety. Second, they give the participants information on the nature of math anxiety and math itself. Participants are tested, lectured to, and given the opportunity to discuss their feelings about themselves and their experiences with mathematics.

Each clinic begins with a description of the CEW Math Anxiety Program and an outline of some of the causes of, and cures for, math anxiety. It is at this point that the students are encouraged to discuss some of their personal feelings about, and experiences with, mathematics. They are told to relax and look around and realize that they are not alone in their feelings of anxiety regarding math.

After this half hour of discussion, the math skills test is administered. The purpose of this test is to help the participants determine which areas of math they need to study. A copy of the placement test is in the Appendix.

The placement test was developed by a number of mathematics educators to measure students' levels of skill in the areas of arithmetic through intermediate algebra. Students are told that they may find the test very difficult or easy, depending on their backgrounds. In fact, some students may be able to answer only a few of the questions on the test. They are instructed to do their best, but not to guess or use a calculator. After completing the test, they are given the answers so that they may score their own tests. They are also given a copy of the placement criteria so that they may see which math courses might be appropriate for them. A copy of the placement criteria is in the Appendix.

Clinic participants are informed that the placement test is simply a guide which they may use and not a perfect predictor. If they score close to the cut-off for algebra (in the 26-30 correct range), they have the choice as to which course they might want to take. If they feel they know more than the test indicates, they can take algebra. If they feel that they were lucky on the test, or guessed at too many answers, they should take the arithmetic course. In any case, it is better to err on the side of taking a course which is too easy than one which is too difficult (i.e., it is better to be a little bored than to be completely lost and frustrated).

Sometimes student scores fall "between the cracks" in the placement scheme. For example, some students score well in algebra, but do poorly in arithmetic. It is necessary for a math instructor to talk individually with those people to see what their future goals specific backgrounds are. In some cases, it is not possible to determine which courses they should take. In such cases, the instructor needs to use his/her best judgment and simply to make a guess.

It is important to have a math teacher talk with students about their choice of courses. The teacher is probably most qualified to help the students determine which courses are most appropriate; it also helps the students to interact with the teacher in a non-mathematical setting, before the class begins. Many students have stated that their former math teachers are a part of, or the major cause of, their math anxiety problems. Interacting with a math teacher in a counselling role helps dispel some of the fears which students have concerning math teachers.

Typically, 60% of the students score in the 0 to 27 correct range on the arithmetic portion of the test and should be enrolled in the arithmetic course. About 30% score at the elementary algebra level, while the remaining 10% are ready for intermediate algebra or higher. Those few students who do very well on the test are given another test to see if they are ready for college algebra or calculus. A brief description of the courses is given in the Appendix.

After discussing the test results and describing the math classes, a brief lecture is given on the uses of math as a problem solving tool, and on math as an interesting subject in its own right. The intent of the lecture is to give the students the idea that math is not just something which was invented to make their lives miserable, but that its purpose is to make life simpler by helping them solve problems. The lecture concludes with a short discussion of the recreational and artistic

aspects of math. A copy of the handout on modular art, which is used in the clinics, is in the Appendix.

The students are then asked to complete the Mathematics Anxiety Rating Scale. This is a ninty-question test which measures the levels of anxiety of students toward math. It is scored by the CEW staff and the results are sent to students a few days after the clinic.

Students are encouraged to call the math instructor or the CEW office if they have any questions about the program or their own math skill levels.

2. Support Groups:

The second component of the program is the support groups. These small groups are led by a counselling psychologist. The participants engage in group discussions concerning the development of specific tools for dealing with math anxiety that may be employed in various mathematical settings. Students with the highest and most debilitating levels of math anxiety benefit most from participating in the support groups. Activities include:

a. Writing a math autobiography, where students recall past experiences with math situations
b. Filling out a sentence completion questionnaire concerning various math situations
c. Keeping a diary of math experiences
d. Writing out their goals relevant to studying math
e. Discussing math study skills
f. Learning assertiveness techniques to help students deal with math teachers in the classroom
g. Developing a personal support system which could be used outside of the class (e.g., becoming friends with others in a math class).

Students who participate in the support groups are strongly encouraged to register for a math class while they are in the group. This allows the students to practice the techniques and ideas which are developed in the groups. It also enables the students to see the effects of the techniques in terms of their learning mathematics.

3. Mathematics Tutorial:

The third component of the program is the math tutorial. Here, students are given the opportunity to work with a math tutor, on a one-to-one basis, outside of the regularly scheduled class hours. An attempt is made to employ one of the instructors as the tutor in order to make the students more comfortable when working with the tutor. This also reinforces the idea that, in order to learn math, a good deal of practice is needed outside of class.

4. Mathematics Courses:

The fourth component of the program is the actual math courses.

It is difficult to imagine how one could overcome math anxiety without actually studying math. CEW offers a wide variety of non-credit and credit math classes, ranging from arithmetic through calculus.

It should be noted that the sequence of courses begins with Arithmetic and Elementary Algebra, a non-credit course, and then progresses to a 5 credit course, GC 1445, Intermediate Algebra, and finally to courses in College Algebra and Calculus, offered through the School of Mathematics. Students who reach this level in their math training are ready for regular college level math courses. If they have any anxiety toward math at this point, it is usually well controlled. They then are able to make the choice, based on their own interests, as to whether or not to pursue a technical career. They are no longer overwhelmingly influenced by negative feelings toward math.

DESCRIPTION OF THE ARITHMETIC AND ELEMENTARY ALGEBRA COURSE

Since most students register for the Arithmetic and Elementary Algebra course, it is described in detail below. The course outline is in the Appendix.

The course is broken up into two parts: arithmetic review, and elementary algebra. It is intended that students take either the arithmetic part or the algebra part, but not both. However, many students who are ready to study algebra also need to work on specific areas of weakness in arithmetic. By having the classes combined, students who are in the algebra course are able to attend those lectures on arithmetic which cover topics of interest to them. The reverse is also possible, although not usually recommended. Students who are studying arithmetic may sit in on the algebra lectures to get a taste of algebra, but they soon find that their lack of skills in arithmetic makes the study of algebra very difficult.

The classes are set up so that two instructors are working with students, in adjacent rooms, for the entire two and one half hours of class. The arithmetic students are given ninty minutes of individualized attention from one instructor while the other instructor lectures to the algebra students. The classes are then switched so that the algebra students can be tutored while the arithmetic students work on new material in the lecture room. More tutor time is provided to arithmetic students because they generally need more of the personal attention of the tutor than do the algebra students. In addition, there is more material in the algebra course than in the arithmetic course.

The term "lecture" is used above to mean that the instructor is the main source of new information (versus the textbook), but it is by no means a monologue, nor a straight discourse on the rules of mathematics.

The lectures cover a wide range of topics, always within the context of new mathematical material, including the nature of mathematics, how to study mathematics, how to study for math tests, what to do when feeling frustrated,

where math is used, the history of math, how to use math as a tool, tricks of the trade (both quantitative and social), the nature of quantitative people, and so on. The main idea woven throughout the course is that math is a language with a certain vocabulary and rules of grammar which must be memorized. Once this is accomplished, math can be used as an effective tool in many different situations. In addition, it is emphasized that everyone can learn math, if they are willing to commit the time and energy to do so. The analogy to learning the Chinese language is given: Chinese is usually thought of as a very difficult language to learn. However, millions of two year old Chinese children learn it very easily. This does not mean that they are necessarily smart -- they just spend all their waking hours listening to it and practicing it until they get it right.

Since the course is non-credit, no formal assignments or tests are required by the instructor. The intent is to make the course as non-threatening as possible for the students. However, students are strongly encouraged to do assigned homework and to take tests. Math is not a spectator sport; one cannot learn math by watching others do it. It must be practiced. Also, one cannot learn to take math tests without taking math tests. Students who feel very anxious about taking tests are strongly encouraged to take many of them. They may begin by taking them at home. Eventually, they may take them on campus, but perhaps in a room by themselves, without the pressures and distractions of others in the room with them. Finally, they progress to taking tests in the room with the tutor, with all the distractions inherent in this situation, including the tutor glaring at them and timing the test. If they can survive this, they are ready for the credit courses. It sometimes takes quite a long time for this to happen. For some students the feeling of anxiety while taking tests never goes away, but it may be reduced to a level where it is simply discomforting, rather than debilitating.

Towards the end of the course, students are encouraged to sign up for further math classes and are advised as to which course would be appropriate for them as a next step. Some want to "relax" for a quarter and not take another math class. This is strongly discouraged for two reasons:

1. They will forget a lot of what they have learned if they stop studying math for a few months

2. They are now "on a roll" and need to continually push themselves where math is concerned. The math anxious person is not cured after a short twelve-week course. He or she must continually push to learn more math and encounter more math situations. Students who take a quarter off usually find it very difficult to start up again at a later date. Their anxiety has taken many years to develop and will not go away quickly.

TEACHING THE MATH ANXIOUS

When teaching a quantitative course to math anxious students, it is important for the students to realize that it is natural to feel frustrated, anxious, discouraged, and angry, along with feeling excited, elated, powerful, awed, and inspired. Math does not come easily. Most people have experienced the frustration of not being able to find the solution to a

quantitative problem. Once students realize that learning math, like learning most other things of value, is hard work, they can feel better about their own abilities.

It needs to be stressed that doing math problems is not like studying English or history. The rules must be followed precisely every time a problem is solved. In a problem requiring a hundred separate operations, one mistake will cause the answer to be wrong. Most students are not used to being this meticulous.

Students also need to realize that, unless they have a large amount of idle time on their hands, they will have to give up something else in their lives in order to learn math. They cannot simply add a math class to their schedules and expect everything else to be the same. Often, the only things which are flexible enough to "adjust" to the math schedule are either leisure time or family activities, both of which are hard to give up.

Once the students have made the decision to commit a significant portion of their day to the study of math, they then have to convince their families and friends that they need to be left alone for those periods of time during the day. They may need to lock themselves in a room and refuse to be disturbed for any reason until they are finished studying. They should study for between one and two hours per day, depending on how much they can take. Without this kind of commitment by the students and their families, the students will be setting themselves up for failure.

Four general points concerning the teaching of math anxious students should be remembered:

1. Students need to be successful in doing math problems right from the start. People feel a tremendous amount of satisfaction when they work out the correct answers to problems. They want to work on more problems right away. If they get those correct, they want more, and so on. Thus, the math teacher must, from the first few minutes of the first class, help students to feel good about themselves in a mathematical setting.

2. The instructor must have a truely positive attitude toward the students and the subject. It must be clear to the students that the instructor really feels good about, and enjoys, the mathematics he/she is teaching, and the class itself.

3. The use of calculators should be encouraged by telling the students that it is all right to use them and by having the teacher use one. It should be remembered that the students are adults, not children. If, in 20 or 30 or 40 years, they have not learned their multiplication tables or the long division algorithm, they should not be made to try it again. It will only stir up bad memories and waste precious time. As the students do more problems and feel more comfortable with mathematics, they will pick up the truely basic skills which the calculator currently does for them. And if they do not, they can always have the calculator do it for them.

4. Finally, the students and the teacher should have fun with the mathematics and with each other.

Notes

Hendel, Darwin D. "The Math Anxiety Program: Its Genesis and Evaluation in Continuing Education for Women," University Measurement Services Center, University of Minnesota, May 19, 1977.

Hendel, Darwin D. and Edith E. Mucke. "Continuing Education for Women, 1960 - 1980: Assessment and Evaluation," University Measurement Services Center, University of Minnesota, August 15, 1980.

Lorenz, Gail E. and Darwin D. Hendel. "Math Anxiety Program Follow-up Study," University Measurement Services Center, University of Minnesota, June, 1981.

Appendix

1. Mathematics Placement Test
2. Interpretation of Math Test Scores
3. Math Anxiety Course Descriptions
4. Modular Art Handout Used in Clinics
5. Course Outline for Arithmetic and Elementary Algebra

-- MATH ANXIETY PROGRAM --

MATHEMATICS TEST

These 45 mathematics questions cover many different types of items. You may use either pencil or pen to mark your answers; mark your answers by circling the answer which you think is correct. If you need to do any figuring, use this booklet.

Please answer all items in this booklet. You will have 60 minutes to complete this test.

1. Add

   10 + 39

   a. 40
   b. 29
   c. 49
   d. 50
   e. None of these

2. Add

   273
   4865
   3680
   76

   a. 7894
   b. 8694
   c. 8884
   d. 8894
   e. None of these

3. Subtract

   204 - 25

   a. 121
   b. 179
   c. 221
   d. 279
   e. None of these

4. Multiply

   25 x 75

   a. 1725
   b. 1825
   c. 3545
   d. 3645
   e. None of these

5. Multiply

   306
   x 52

   a. 1872
   b. 2142
   c. 15,912
   d. 18,702
   e. None of these

6. Divide

   126 ÷ 9

   a. 15
   b. 16
   c. 17
   d. 26
   e. None of these

7. Divide

   $70\overline{)68600}$

   a. 98
   b. 975
   c. 980
   d. 985
   e. None of these

8. Divide

   937 by 24

   a. 34 R. 21
   b. 39 R. 1
   c. 309 R. 1
   d. 390 R. 1
   e. None of these

9. The factor set of a number is the set of divisors of that number. The factor set of 28 is:

   a. {1,2,3,4,5,6,7,8,9,10,11,12,13,14}
   b. {1,2,4,7,14,28}
   c. {1,2,7}
   d. {2,7}
   e. None of these

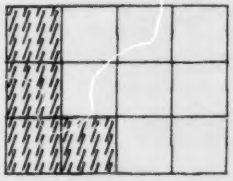
10. A prime number is a number greater than 1 that is divisible only by itself and 1. Which of the following is a prime number?

    a. 39
    b. 23
    c. 36
    d. 27
    e. None of these

11. The greatest common factor of two numbers is the greatest number that divides both numbers.
    The greatest common factor of 36 and 40 is:

    a. 4
    b. 1
    c. 1440
    d. 720
    e. None of these

12. What fractional portion of the figure is shaded?



    a. 4
    b. $\frac{4}{8}$
    c. $\frac{4}{12}$
    d. $\frac{8}{12}$
    e. None of these

13. Find a fraction equal to $\frac{36}{48}$

    a. $\frac{1}{2}$
    b. $\frac{1}{4}$
    c. $\frac{3}{4}$
    d. $\frac{1}{8}$
    e. None of these

(continued on next page)

14. Which fraction represents a number greater than $\frac{7}{8}$?

a. $\frac{7}{12}$

b. $\frac{8}{9}$

c. $\frac{1}{2}$

d. $\frac{4}{15}$

e. None of these

15. Add

$\frac{3}{5} + \frac{9}{20}$

a. $\frac{12}{35}$

b. $1\frac{1}{20}$

c. $\frac{21}{100}$

d. $\frac{3}{5}$

e. None of these

16. Add

$1\frac{3}{8}$

$+ 2\frac{7}{8}$

a. $3\frac{1}{4}$

b. $3\frac{4}{8}$

c. $3\frac{10}{16}$

d. $4\frac{1}{4}$

e. None of these

17. Subtract

$1\frac{1}{3}$ from $2\frac{1}{4}$

a. $\frac{5}{12}$

b. $\frac{11}{12}$

c. $1\frac{1}{12}$

d. $1\frac{7}{12}$

e. None of these

18. Multiply

$\frac{2}{3} \times \frac{5}{7}$

a. $\frac{7}{10}$

b. $\frac{10}{21}$

c. $\frac{14}{15}$

d. $\frac{29}{21}$

e. None of these

19. Multiply

$2\frac{2}{3} \times 3\frac{1}{4}$

a. $5\frac{1}{6}$

b. $6\frac{1}{6}$

c. 8

d. $8\frac{2}{3}$

e. None of these

20. Divide

$\frac{2}{3}$ divided by $\frac{5}{12}$ =

a. $\frac{8}{85}$

b. $\frac{5}{8}$

c. $\frac{8}{5}$

d. $\frac{18}{5}$

e. None of these

21. Divide

$\frac{2}{3} \div 3$

a. $\frac{2}{15}$

b. $\frac{5}{6}$

c. $\frac{6}{5}$

d. $\frac{15}{2}$

e. None of these

(continued on next page)

22. 0.073 can be written in fractional form as:

a. $\frac{73}{10}$

b. $\frac{73}{100}$

c. $\frac{73}{1000}$

d. $\frac{73}{10000}$

e. None of these

23. Which of the following numbers is greater than 5.0013?

a. 4.9999
b. 5.01
c. 5.001
d. 5.000998
e. None of these

24. Add

7.38 + 28.924

a. .29662
b. .36304
c. 29.662
d. 36.304
e. None of these

25. Subtract

6 - .037

a. 0.031
b. 5.63
c. 5.963
d. 6.037
e. None of these

26. Rounding off 5.0349 to two decimal places, we get

a. 5.00
b. 5.03
c. 5.035
d. 4.04
e. None of these

27. Multiply

0.3 x 0.6

a. 0.0018
b. 0.018
c. 0.18
d. 1.8
e. None of these

28. Divide

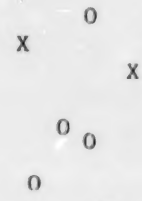
$0.46\overline{)147.2}$

a. 0.32
b. 3.2
c. 32
d. 320
e. None of these

29. Write $\frac{5}{8}$ as a decimal.

a. 0.16
b. 0.625
c. 1.6
d. 6.25
e. None of these

30. Name the ratio of X's to O's.



a. $\frac{3}{7}$

b. $\frac{4}{7}$

c. $\frac{3}{4}$

d. $\frac{4}{3}$

e. None of these

31. What is the daily rate of earnings of a woman who is paid $50.00 for 4 days work?

a. $10.00
b. $12.50
c. $50.00
d. $200.00
e. None of these

32. What number can be put in place of X to make $\frac{3}{10} = \frac{X}{90}$ true?

a. 3
b. 9
c. 27
d. 30
e. None of these

33. Write .76 as a percent.

a. .0076%
b. .076%
c. .76%
d. 7.6%
e. None of these

34. 25 is ?% of 125.

a. $\frac{1}{5}$

b. 5
c. 20
d. 31.25
e. None of these

(continued on next page)

35. 4% of 175 = ?.

a. .7
b. 7
c. 70
d. 700
e. None of these

36. $7200 is to be shared equally by Harry, Barry, Larry, and Jim. Jim decides to give $\frac{2}{5}$ of his share to charity. How much does Jim give to charity?

a. $360
b. $720
c. $900
d. $1800
e. None of these

37. Barry typed a manuscript. He made $39.00 for twelve hours of typing. How much did he make per hour?

a. $2.95
b. $3.25
c. $27.00
d. $468
e. None of these

38. Which of the following is equal to $\frac{X^7 Y^3}{X^{-3} Y}$

a. $X^{10} Y^2$
b. $X^4 Y^2$
c. $X^{-21} Y^3$
d. $X^{1/3} Y^3$
e. $X^{10} Y^3$

39. Which of the following is equal to $(x^2 + 3x + 2) + (x^3 + 5x^2 + 3)$

a. $10x^8 + 5$
b. $15x^8$
c. $10x^3 + 5$
d. $x^3 + 6x^2 + 3x + 5$
e. None of these

40. Which is the simplest form of $3(2x + y) - 2(x - 2y) + 3x$

a. $14xy$
b. $7xy$
c. $7x - y$
d. $7x + 7y$
e. $11x - y$

41. What value of y solves $6y - 10 = 2y + 14$

a. $y = 1/2$
b. $y = 6$
c. $y = 4$
d. $y = 3/2$
e. $y = -6$

(continued on next page)

42. If $x + y = 3$ and $2x + 3y = 7$, which values of x and y in the form (x,y) solve this pair of equations simultaneously?

a. $(3,7)$
b. $(2,1)$
c. $(3,0)$
d. $(7,3)$
e. $(1,2)$

43. Which of the following is the equation of the line whose slope is 5 and whose y intercept is -3

a. $y - 3x = 5$
b. $3y + 5x = 0$
c. $y = 5x - 3$
d. $y + x = -3/5$
e. None of these

44. Which of the following statements correctly follows from $-x \leq -5$

a. $x \leq 5$
b. $x \geq 5$
c. $-x \geq -5$
d. $x > 5$
e. $x < 5$

45. Which of the following is equivalent to $(x + 3y)^2$

a. $2x + 6y$
b. $x^2 + 6xy + 9y^2$
c. $x^2 + 9y^2$
d. $\frac{x + 3y}{2}$
e. $x^2 + 3xy + 9y^2$

-- MATH ANXIETY PROGRAM --

MATHEMATICS TEST RESULTS

To correct your test results, follow this procedure for each type of item (e.g., Addition and Subtraction of Whole Numbers).

-- First check to see how you answered an item;

-- If your answer is the same as the lettered answer in the correct answer column, write "1" in the next column, if your answer is different, write "0";

-- When you've finished correcting each type of item, add together the 1's and 0's and write "Your Score" in the column to the far right;

-- Then go on to the next type of item;

-- To get your "Total Arithmetic Score", add together the numbers you wrote in the column to the far right.

Type of Item	Item Numbers	Correct Answer	Write "1" if your answer is the same as the correct answer, and "0" if your answer is different	Your Score
1. Addition and Subtraction of Whole Numbers	1	c	____	
	2	d	____	
	3	b	____	____
2. Multiplication of Whole Numbers	4	e	____	
	5	c	____	____
3. Division of Whole Numbers	6	e	____	
	7	c	____	
	8	b	____	____
4. Properties of Numbers	9	b	____	
	10	b	____	
	11	a	____	____
5. Meaning of Fractions and Rational Numbers	12	c	____	
	13	c	____	
	14	b	____	____
6. Addition and Subtraction of Fractions	15	b	____	
	16	d	____	
	17	b	____	____
7. Multiplication and Division of Fractions	18	b	____	
	19	d	____	
	20	c	____	
	21	e	____	____
8. Meaning of Decimals	22	c	____	
	23	b	____	____
9. Addition and Subtraction of Decimals	24	d	____	
	25	c	____	
	26	b	____	____
10. Multiplication and Division of Decimals	27	c	____	
	28	d	____	
	29	b	____	____
11. Ratios, Rates, and Proportions	30	c	____	
	31	b	____	
	32	c	____	____
12. Percentages	33	e	____	
	34	c	____	
	35	b	____	____
13. Problem Solving	36	b	____	
	37	b	____	____

TOTAL ARITHMETIC SCORE = _____

(To get your total score, add together the number you got correct for each of the types of items listed above)

Algebra Score	38	a	____	
	39	d	____	
	40	d	____	
	41	b	____	
	42	b	____	
	43	c	____	
	44	b	____	
	45	b	____	____

CEW MATH ANXIETY DIAGNOSTIC CLINIC
INTERPRETATION OF MATH TEST SCORES

There are two scores from the math test: Arithmetic Total and Algebra Total. First, look at the Arithmetic Total:

--If the score is 0-27, you should take an Arithmetic course.
--If the score is 28-37, you should look at the Algebra Total.

--If the Algebra Total is 0-3, you should take Elementary Algebra.
--If the Algebra Total is 4-6, you should take Intermediate Algebra.
--If the Algebra Total is 7-8, you are off the scale of the test and need to take an additional test. You are at the College Algebra or Calculus level. See Doug or Joan for this test.

COURSE LISTINGS

Arithmetic:

CEW Arithmetic and Elementary Algebra (do the arithmetic portion of this course).

GC 1433 Basic Mathematics (do the arithmetic portion of this course).

GC 1434 Math Skills Review (this is all arithmetic).

Math 0005 Arithmetic for Adults.

Elementary Algebra:

CEW Arithmetic and Elementary Algebra (do the algebra portion of this course).

GC 1433 Basic Mathematics (do the algebra portion of this course).

GC 1435 Elementary Algebra.

Math 0006 Elementary Algebra.

Intermediate Algebra:

GC 1445 Intermediate Algebra.

Math 0009 Intermediate Algebra.

College Algebra:

Math 1111 College Algebra, Analytic Geometry.

Students wishing to enter the School of Management for the purpose of working on a business degree need to take Math 1111 College Algebra, Math 1142 Short Calculus, and Math 1131 Finite Math.

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Continuing Education for Women
200 Wesbrook Hall
77 Pleasant Street S.E.
University of Minnesota
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373-4026

A Modular Art design is a visual representation of a particular arithmetic operation. The example given below, and illustrated on the red, white and blue quilt, is based on the following multiplication table:

	0	1	2	3
0	0	0	0	0
1	0	1	2	3
2	0	2	4	6
3	0	3	6	9

The above multiplication table is converted to a modulo 4 table by subtracting a multiple of 4 from every number in the table larger than 3. For example,

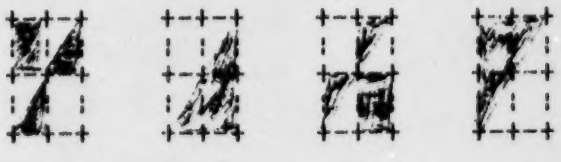
4 becomes 4 - 4 = 0
6 becomes 6 - 4 = 2
9 becomes 9 - 4 = 5, and 5 - 4 = 1

Changing to modulo 4 insures that only the digits 0,1,2 and 3 will appear in the table. This type of arithmetic is used when telling time. If it is 11:00 am now, in two hours it will be 11:00 + 2 = 13:00. However, we do not say 13:00; we subtract 12 from the 13:00 and say the time is 1:00 (this is called modulo 12 arithmetic).

The modulo 4 multiplication table looks like the following:

	0	1	2	3
0	0	0	0	0
1	0	1	2	3
2	0	2	0	2
3	0	3	2	1

Next, each digit (0, 1, 2, 3) in the table is represented by a different pattern as follows:



0 1 2 3

These patterns are placed on a rectangular grid to form the upper left hand one fourth of the total design. This basic quarter is then reflected about its right hand edge to give a rectangular pattern, and the rectangular pattern is then reflected about its bottom edge to give the complete design.

Other designs can be made by following a similar procedure using different arithmetic operations, modulos and grid patterns.

References on Modular Art

Forseth, Sonia. "Using Mathematical Structures to Generate Artisitc Designs," THE MATHEMATICS TEACHER, May, 1974, pp 393-398.

Gudder, Stanley. A MATHEMATICAL JOURNEY, McGraw Hill Book Company, 1976, pp 107-111.

Other References

Bergamini, David. MATHEMATICS, Time-Life Books, 1963.

Koselman, Stanley and Joseph Warren. MIND OVER MATH. McGraw Hill Book Company, 1978.

Course: CEW Arithmetic and Elementary Algebra
Section: Evening, Minneapolis Campus
Instructors: Maren Watson and Doug Robertson
Office: N367 Elliott Hall
Office Phone: 373-4026
Office Hours: To be announced

Course Text: INTRODUCTORY MATHEMATICS, by McKeague (Wadsworth, 1981) or
ELEMENTARY ALGEBRA, by McKeague, (Academic Press, second edition, 1981).
Texts are available in Williamson Hall Bookstore.

Classrooms: S134 and S135 Kolthoff Hall
Class times: 5:30 to 8:00 pm, Wednesdays

Class Format: The class will be broken up into two parts: Elementary Algebra and Arithmetic Review.

5:30-7:00 Lectures on algebra in S134 (students who do not want to attend the algebra lectures may study, take tests, or work with Maren in room S135).
7:00-7:05 Break (students switch rooms).
7:05-8:00 Lectures on arithmetic in S134 (students who do not want to attend the algebra lectures study, take tests, or work with Maren in room S135).

Introduction:

The instructors assume that you want to learn mathematics and that you are willing to spend a significant amount of time and make a determined effort in order to accomplish this goal. The class time is to be used each evening for listening to lectures, reading the textbook, doing homework exercises, taking tests, and getting help from the instructors. In order to maximize your learning you will have to spend a number of hours studying outside of class (the more you study, the more you will learn).

Placement:

If you are not sure which part of the course you should work on, ask Doug or Maren for the Arithmetic Planning Test. This is a test of your knowledge of basic mathematics and can be used to determine which areas of arithmetic and elementary algebra you need to work on. If you think you know where your weak points are, or if you took the test during the Diagnostic Clinic, you need not take the test.

Arithmetic:

Those students who will study the arithmetic part of the course will use INTRODUCTORY MATHEMATICS, by McKeague (Wadsworth, 1981), for a textbook. The arithmetic section of the course is divided into the following five areas:

Area	Topic	Chapters	Pages	Number of Tests
I	Whole numbers	1-2	1-82	2
II	Fractions	3-4	83-148	2
III	Decimals & ratios	5-6	149-208	2
IV	Percents	7	209-246	1
V	Measurement and integers	8-9	247-314	2

Algebra:

Those students who will study the algebra part of the course will use ELEMENTARY ALGEBRA, by McKeague (Academic Press, second edition, 1981), for a textbook. The algebra section of the course is divided into the following five areas:

Area	Topic	Chapters	Pages	Number of Tests
I	Integers, equations, and inequalities	1-2	1-82	2
II	Graphing, exponents, and polynomials	3-4	83-172	2
III	Factoring	5	173-202	1
IV	Rational expressions	6	203-244	1
V	Roots and radicals	7	245-276	1

Homework:

Doing homework is essential if you are to succeed in the course. Homework problems will be assigned based on the particular areas of the textbook which you study. These homework problems are to be worked out and the answers checked using the key in the back of your textbook. The homework is NOT to be handed in. It is suggested that you work out the problems on regular lined paper and not in your textbook. If you tear up your textbook, or mark it excessively, it will be difficult for you to review for tests and the bookstore will not buy it back. Make sure you save all your homework until the end of the semester so that you can study from it for the chapter tests.

Calculators:

You may use a calculator while doing your homework and while taking tests.

Attendance:

Attending class is essential if you are to complete the work for which you are registered. If you have to miss class, make sure that you work through the material at home.

Tests:

Tests for the course are optional and are given on an individual basis. When you are ready to take a particular test, ask for the one you want. Tests can be re-taken if you so desire. You may use a calculator on all tests, but you should be aware that when you take 'standardized' tests you are normally not allowed to use a calculator; a calculator is a real time saver, but if you are planning to take tests for job advancement, GRE, etc., you will have to learn to do the problems without the aid of a calculator.

Self-Pacing:

This is a 'self-paced' course. This means that you may move through the material at a rate which you feel is best for you. If you finish the required material before the last evening of class, you may decide either to wait until next semester to continue your study of mathematics or to continue study and learn more mathematics this semester.

If you would like to move through the material slower than the lectures, you may do so; one of the instructors will be available for tutoring while the lectures are being given in the next room.

Grades:

Since this is a non-credit course, no grades are given. However, if grades were assigned, they would be as follows:

A11	100 - 96%	C6	75 - 73
A10	95 - 91	C5	72 - 70
B9	90 - 86	D4	69 - 65
B8	85 - 80	D3	64 - 60
C7	79 - 76	N	Under 60%

Syllabus:

On the next page is a listing of the course topics and the approximate dates on which they will be covered in lecture:

Week	Sections	ALGEBRA Topics (lectures are 5:30 - 7:00)
1	1.1-1.7	Signed numbers
2	2.1-2.4	Solving Equations
3	2.5-2.7	Word problems and inequalities
4	3.1-3.3	X-Y graphs
5	3.4-3.7	Systems of equations
6	4.1-4.3	Exponents
7	4.4-4.7	Polynomials
8	5.1-5.4	Factoring
9	5.5-6.1	Word problems and fractions
10	6.3-6.7	Rational expressions (skip 6.2)
11	7.1-7.3	Roots and radicals
12	7.4-7.6	Radical equations

Week	Sections	ARITHMETIC Topics (lectures are 7:05 - 7:30)
1	1.1-1.2	Place value, comm, assoc, prop of addition
	1.4-1.6	Comm, assoc prop of mult, div, exponents
2	2.2, 2.5	Rounding, distributive property
	2.7-2.8	Order of operations, prime factoring
3	3.1-3.6	Fractions
4	4.1-4.5	Mixed numbers
5	5.1-5.5	Decimals
6	6.1-6.3	Ratios, rates and unit pricing
7	6.4-6.5	Proportions and word problems
8	7.1-7.3	Defn of percent, conversions, equations
9	7.4-7.7	Percent word problems
10	same	More percent word problems
11	[illegible]	Length, perimeter and area
[illegible]	[illegible]	Volume, weight and the Metric System